

Environmental scanning, supply chain integration, responsiveness, and operational performance

ES, SCI, SCR
and operational
performance

An integrative framework from an organizational information processing theory perspective

787

Received 6 July 2018
Revised 19 October 2018
13 December 2018
2 April 2019
10 May 2019
Accepted 21 May 2019

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Abstract

Purpose – It remains unclear how environmental scanning (ES) can generate firm performance through supply chain management (SCM) practices. The purpose of this paper is to investigate the effects of ES on operational performance through supply chain integration (SCI) and supply chain responsiveness (SCR).

Design/methodology/approach – The scanning–interpretation–action–performance (SIAP) model and organization information processing theory (OIPT) are used to explain the ES–SCI–SCR–performance (S–I–A–P) relationships, which were tested by structural equation modeling of survey data of 329 manufacturing firms in China.

Findings – The results indicate that ES has a significant positive effect on SCI and SCR. SCI is significantly and positively related to SCR. SCR partially mediates the relationship between ES and operational performance, and fully mediates the relationship between SCI and operational performance.

Practical implications – Supply chain managers should collaborate with senior executives to obtain signals from ES activities, as input for building SCI and SCR and use SCI as a joint interpretation mechanism of ES signals for developing SCR to reap operational advantages in the rapidly changing business environment.

Originality/value – Strategic management academics and practitioners have explicitly emphasized the importance of ES in developing strategic plans but are unsure about the role of SCM in creating operational advantages through ES. Using the SIAP model, this study theorizes and demonstrates how SCI and SCR transform signals from ES into operational performance. In doing so, a more precise application of OIPT is explicated in the supply chain context.

Keywords China, Operational performance, Supply chain integration, Environmental scanning, Supply chain responsiveness

Paper type Research paper



1. Introduction

The demise of the car company Rover, according to the post mortem case study analysis by Oliver *et al.* (2008), was caused primarily by a disconnect between the management team and the market. This disconnect was created by a failure to adequately scan the

International Journal of Operations
& Production Management
Vol. 39 No. 5, 2019
pp. 787-814
© Emerald Publishing Limited
0144-3577
DOI 10.1108/IJOPM-07-2018-0395

environment and resulted in poor product portfolio choices, missed opportunities to capture innovation and inefficient production processes that increased product cost. Environmental scanning (ES) is defined as “scanning for information about events and relationships in a company’s outside environment, the knowledge of which would assist top management in its task of charting the company’s future course of action” (Aguilar, 1967, p. 1). Through ES, senior executives gather signals about competitors’ strategies, technological innovations, governmental regulations, customer needs and supplier conditions (Daft *et al.*, 1988; McGee and Sawyerr, 2003) to ensure business strategy fit (Cousins *et al.*, 2011; Garg *et al.*, 2003; Hambrick, 1981). As a key strategic management concept (e.g. Aguilar, 1967; Hambrick, 1981) ES is regarded as a prerequisite for developing strategic plans (Beal, 2000; Elenkov, 1997; Hambrick, 1981) in dynamic and complex business environments (Hambrick, 1982).

While the strategic management literature emphasizes using ES for information gathering to reduce strategic uncertainty, the links between ES and performance remain little understood. The collapse of Rover in 2005 reminds us of the importance of ES for strategic planning and operational aspects of firms; how signals from ES must be interpreted by members of a supply chain so they can respond appropriately to improve performance. The organizational information processing theory (OIPT) argues that uncertainty necessitates reducing information processing needs and/or increasing information processing capacities (Daft and Lengel, 1986; Galbraith, 1973). As such, approaches to reducing information processing requirements through strategies such as organizational designs, liaisons, boundary spanning roles and lateral information systems (Galbraith, 1973) have been explored in the Operations Management (OM) literature (Flynn and Flynn, 1999). However, the capacities of the supply chain to process information (interpret) and respond remain unexplored.

This study argues the ES–performance links can be more fully explicated by investigating how firms interpret ES signals and subsequently take supply chain actions. While the strategic management research argues the importance of ES, it lacks an overarching framework to explain how ES generates performance. Toward that end, we introduce a structured framework, the scanning–interpretation–action–performance (SIAP) model (Thomas *et al.*, 1993). The SIAP model positions “scanning” (S), e.g., ES, as a critical first step in organizational adaptation to environmental changes (Aguilar, 1967; Ebrahimi, 2000; Hambrick, 1981). The model recognizes the difficulty senior executives have spotting weak signals which may be crucial for generating strategic insights and rapid response (Daft *et al.*, 1988). Strategic uncertainty can be caused by distorted information and push senior executives toward a situation called equivocality (Daft and Macintosh, 1981) wherein different actors use different frames to interpret the same information (Weick, 1979). The value of SIAP model is that once information from the external environment is “interpreted” (I) accurately (Ebrahimi, 2000) it can be transformed into strategic “actions” (A) aligned with the environment to generate “performance” (Beal, 2000; Bourgeois, 1980; Yasai-Ardekani and Nystrom, 1996).

We emphasize it is the quick “action” through supply chain responsiveness (SCR) informed by accurate “interpretation” that helps firms stay ahead of competitors (Fabbe-Costes *et al.*, 2014) and achieve superior performance (Beal, 2000). Early evidence suggests it is the faster response to environmental information than competitors, not signals from ES, that contributes to distinctive advantages (Hambrick, 1982). Moreover, to quickly respond to changes in customer demand (Kim and Lee, 2010) or supply disruption risks, firms must realign supply chain resources with the environment (Ambulkar *et al.*, 2015). As such, we argue supply chain integration (SCI) acts as a supply chain information processing and “joint interpretation” mechanism to reduce uncertainty and equivocality and to create shared meanings and goals that can form the basis for SCR. However, empirical research on the roles of supply chain management (SCM) practices in the SIAP model remains scarce. To address these research gaps this study integrates the concept of ES as

“scanning,” SCI as “interpretations” of signals from ES to inform SCR as “actions” to create “performance” in the SIAP model.

In summary, this study integrates the strategic management and SCM literatures to explain the relationship between ES and performance. While the strategic management literature provides information on “scanning” through ES, applying the SIAP model (Thomas *et al.*, 1993) will explain how ES creates performance through SCI as “joint interpretation” and SCR as “quick action.” The supply chain literature has recently recognized that ES can support responses to disruptions (Ambulkar *et al.*, 2015), sensing of regulatory changes (Nair *et al.*, 2016) and sustainability risks (Fabbe-Costes *et al.*, 2014). In the context of firms spending time scanning and learning from the environment (ES) to better respond to disruption risks (SCR), we contribute to the SCM literature by expanding the work of Ambulkar *et al.* (2015) by adding that SCI can act as an interpretation mechanism of ES signals to inform SCR. We also demonstrate that existing supply chain knowledge can inform the strategic management literature and senior executives. For example, we know SCI can support SCR by reducing uncertainty (Danese *et al.*, 2013), support responses to customer demand (Ralston *et al.*, 2015) and increase commitment to a more responsive supply chain through strategic collaboration (Kim and Lee, 2010). The “interpretation” role played by SCI to reduce uncertainty and equivocality and the quick response “actions” by SCR when incorporated into the SIAP model expand the knowledge base by testing an ES–SCI–SCR–performance conceptual model. From a practical perspective, this study reveals how supply chain managers may better exploit ES activities carried out by senior executives by integrating them into the implementation of SCI and SCR strategies.

2. Theoretical background

2.1 Key concepts and literature review

This section clarifies definitions of key concepts: ES, SCI and SCR, followed by a brief review of the related state-of-the-art literature.

2.1.1 Environmental scanning. ES involves gathering information about events, trends and relationships from the external environment as input for the planning of an organization’s course of action (Aguilar, 1967). ES absorbs information about emerging issues, situations and potential pitfalls from the external environment that potentially influence a firm’s decision-making process (Albright, 2004). ES also enables firms to identify external competitive, social, economic and technical issues (Albright, 2004; Aguilar, 1967; Hambrick, 1982; Stoffels, 1994). ES informs the potential influences from external environments and how firms can respond strategically in a timelier and more effective manner (Albright, 2004). ES is viewed as an effective tactic helping firms adapt to the external environment (Albright, 2004; Beal, 2000; Fabbe-Costes *et al.*, 2014). To survive in today’s dynamic and competitive marketplace firms must adequately understand and interpret the signals derived from the external environment and systematically identify, gather, analyze and process external environmental information (Aguilar, 1967; Albright, 2004; Hambrick, 1982; Hough and White, 2004).

Past studies show that ES is often carried out by senior executives or specialized scanning departments (Daft *et al.*, 1988; Daft and Lengel, 1986). Some firms may use employees at different levels to perform scanning tasks, and there is a variety of scope, geographical coverage and futurity of scanning (Thomas *et al.*, 1993). The environment can be divided into two layers. The first layer is the task environment which has direct interactions with the firms (e.g. customers, markets, competitors and suppliers) and the second is the general environment which is an outer environment related to social, demographic and economic sectors (Daft *et al.*, 1988). It remains an ongoing debate whether

the two layers (task and general environments) should be scanned in combination or separately (Bourgeois, 1980) and whether the search of environments should be broadened or narrowed (Srinivasan *et al.*, 2011). To improve the validity of our study, we conceptualize ES based on task environment (i.e. customers, markets, competitors and suppliers) since it is where strategic uncertainty is perceived as high (Daft *et al.*, 1988) and it is closely related to SCI and SCR. Given that perceived strategic uncertainty tends to increase scanning frequency (Daft *et al.*, 1988), the measurement of ES also considers whether scanning activities have been routinely carried out.

Though the ES literature provides insight into information gathering for strategic foresight, there are a number of limitations. The literature focuses more on understanding information gathering behavior (Daft *et al.*, 1988), design of organization structures to reduce information needs and the use of liaison, boundary spanning integrators and lateral information systems (Galbraith, 1973). Less is known about the interpretation aspect of information processing capacity. While it is important to know what environments to scan and how to spot weak signals (Daft *et al.*, 1988), Hambrick (1982) shows that it is the ability to act on the environmental information that leads to distinct competitive advantage. A similar argument is that know-what (information to scan) and know-how (how to run operations) are equally important for formulating manufacturing strategy (Paiva *et al.*, 2008).

Firms need to clarify what the future may hold especially when the environment is highly uncertain and equivocal. Foresight can be created when business partners interpret the environment together to jointly describe and agree upon what will happen in the future (Cuhl, 2003). Thus, there is a need to better understand joint interpretation activities and their connection to scanning. Moreover, although ES is a key concept in the strategic management literature (e.g. Aguilar, 1967; Hambrick, 1981, 1982) its application and importance in a supply chain context is nascent (Ambulkar *et al.*, 2015; Fabbe-Costes *et al.*, 2014). While the supply chain literature focuses on the sharing of operational information (demand, capacity, inventory and supply) with suppliers and customers, the scanning of strategic information related to competitors, markets, wider customer needs, technologies, society, governmental regulations and politics (Badri *et al.*, 2000; Fabbe-Costes *et al.*, 2011) are not well integrated.

2.1.2 Supply chain integration. SCI is generally defined as strategic collaboration among supply chain partners through information sharing and coordination of decisions (Flynn *et al.*, 2010; Wong *et al.*, 2011; Wu *et al.*, 2006; Yu *et al.*, 2017). Academics have long articulated the importance of building a strategic collaboration between a firm and its supply chain partners, but their arguments have generally been from the resource-based and relational views (Bowersox *et al.*, 2003; Flynn *et al.*, 2010; Wu *et al.*, 2006; Yu *et al.*, 2013). The use of OIPT may help better explain the role of SCI in enabling information sharing and alignment as a way to reduce strategic uncertainty. Additionally, SCI can facilitate information processing by coordinating strategic supply chain activities (such as forecasting and planning) with trading partners (Yu *et al.*, 2017, 2018). Such coordination activities, supported by boundary spanning and liaison roles, can reduce strategic uncertainty through face-to-face and group meetings (Daft and Macintosh, 1981).

However, another role of SCI is to reduce equivocality (Daft and Macintosh, 1981). Equivocality restricts goal alignment. Through strategic collaboration and joint interpretation of information (Srinivasan and Swink, 2015; Swink and Schoenherr, 2015; Wong *et al.*, 2011) equivocality can be reduced such that shared schema and goals can be reached (Bowersox *et al.*, 2003; Sheu *et al.*, 2006). By extending the notion of a firm as an information processing system (Daft and Weick, 1984) into the supply chain context, we position SCI as a joint information processing agent reducing uncertainty and equivocality (Daft and Macintosh, 1981). As such, SCI helps align the external operations (Flynn *et al.*, 2010; Kim, 2009;

Huo, 2012; Wong *et al.*, 2011) and leverage the resources and knowledge of suppliers and customers (Cao and Zhang, 2011).

Even though SCI can have positive effects on all dimensions of operational performance, these effects are not universal (Danese *et al.*, 2013; Mackelprang *et al.*, 2014; Wong *et al.*, 2011). Since quick response is suited to environments with high uncertainty (Daft *et al.*, 1988), SCI may improve interpretation of ES signals and thus lead to better SCR. There is already some evidence for the positive link between SCI and SCR (Danese *et al.*, 2013; Ralston *et al.*, 2015) serving as a basis for explaining the missing ES–operational performance links.

The present study acknowledges SCI can have different foci, e.g., technology integration and activity integration (Vickery *et al.*, 2003; Wu *et al.*, 2006). While earlier studies conceptualize SCI as a unidimensional meta construct (Vickery *et al.*, 2003; Wu *et al.*, 2006; Yu *et al.*, 2017, 2018), SCI is elsewhere divided into two dimensions – internal and external (Danese *et al.*, 2013). External integration is further divided into customer and supplier integration (Flynn *et al.*, 2010; Jacobs *et al.*, 2007; Swink *et al.*, 2007; Wong *et al.*, 2011). However, the use of different dimensions and scales to measure SCI may be one of the reasons studies of SCI have reached disparate findings (Danese *et al.*, 2013; Mackelprang *et al.*, 2014). The division of SCI into different dimensions has created a new challenge to research. Even though evidence shows internal, supplier and customer integration can positively affect responses to customer demand (Droge *et al.*, 2012; Ralston *et al.*, 2015; Wong *et al.*, 2011), there is evidence of insignificant effects (see meta-analysis of Mackelprang *et al.*, 2014), varying performance effects of each SCI dimension (Danese *et al.*, 2013; Wong *et al.*, 2011), and interaction effects among SCI dimensions (Flynn *et al.*, 2010). No theory or study, so far, has fully theorized or explained the insignificant, interaction, or varying effects among SCI dimensions.

The focus of this study is not to address the issues arising from the division of SCI into different dimensions, but rather the focus is to understand the roles of SCI in facilitating the effects of ES and SCR on operational performance. Since the conceptualizations of ES and SCR encompass suppliers, customers, markets, and competitors, our theory considers “joint integration” among all of them through SCI as an aggregated construct. Dividing SCI into discrete dimensions would lead to inconsistency in the level of abstraction in our theory (e.g. no division of supplier and customer for ES and SCR, but dividing SCI into internal, supplier and customer). To maintain a parsimonious theoretical model, avoid the potential complex interactions and varying effects among SCI dimensions, we have chosen to focus on conceptualizing SCI as an aggregated construct.

2.1.3 Supply chain responsiveness. Supply chain responsiveness is defined as the extent to which a firm along with its supply chain partners responds to changes in the business environment (Williams *et al.*, 2013; Wang and Wei, 2007; Wu *et al.*, 2006; Yu *et al.*, 2018). To survive in a rapidly changing environment firms seek to develop responsive supply chains (Malhotra and Mackelprang, 2012; Williams *et al.*, 2013). SCR entails quickly responding to changing customer/supplier needs and competitor strategies by developing new products/services or adjusting supply chain operations to match the changing markets through strategic collaboration with partners (Kim and Lee, 2010; Lee, 2004; Wu *et al.*, 2006). This conceptualization reflects a supply chain’s overall responsiveness to changes in demand and supply (Williams *et al.*, 2013). Thus, SCR comes from not only the firm itself but also its supply chain partners when the entire supply chain is able to effectively respond to demands from each supply chain member and the business environment (Kim *et al.*, 2006; Kim and Lee, 2010; Wu *et al.*, 2006; Yu *et al.*, 2018).

This study acknowledges the possible overlaps in terms of the conceptualizations between SCR and supply chain flexibility and agility. The term responsiveness refers to being quick (speedy) in responding to changing market or customer needs, which can be

achieved with any of the following antecedents: short lead time, quick response capability, flexibility, agility and visibility. The supply chain literature assumes supply chain agility includes both responsiveness and flexibility (Christopher and Peck, 2004; Van Hoek *et al.*, 2001) thus indicating a distinction and hierarchy in conceptualizations. Some studies consider a wider scope of SCR by including flexibility and delivery performance as components of the construct (Danese *et al.*, 2013; Droge *et al.*, 2012), which is appropriate as long as the theory considers all these components. We understand our conceptualisation of SCR based on quick response can be viewed as a limitation, but it is also a strength because we strictly adhere to our theoretical domain and we use a unidimensional SCR construct to avoid effect size errors.

Herein, following previous work (Wu *et al.*, 2006; Yu *et al.*, 2018), we focus on overall indicators of responsiveness, e.g., the ability to quickly respond to changes in the needs of market, customer, supplier and strategies of competitors instead of the many possible antecedents such as flexibility, agility, visibility, etc. This approach maintains the unidimensionality of the SCR construct and therefore improves the parsimoniousness of the theoretical model. Since OIPT considers that environmental uncertainty arises from markets, customers, suppliers and competitors, we conceptualize ES to reflect this scope of task environment (customer, supplier, competitor and market) and therefore SCR also represents the ability to quickly respond to changes in the task environment.

2.2 Organizational information processing theory

It has long been recognized that firms must adapt to their business environments to survive and prosper (Hambrick, 1982). The more environmental uncertainty facing a firm, the more information it needs to gather and process to achieve a better performance (Bode *et al.*, 2011). The OIPT argues that as uncertainty increases information processing capacity must also increase to fit with the information needs (Daft and Lengel, 1986). OIPT explains organizational behavior (such as strategy and decision making) by examining the information flows occurring within and across organizational boundaries (Daft and Weick, 1984; Smith *et al.*, 1991). OIPT posits that coping with uncertainty through gathering, processing and communicating information from the business environment is the main task in organizational design (Daft and Weick, 1984; Gattiker and Goodhue, 2004; Hult *et al.*, 2004; Swink and Schoenherr, 2015). Research has shown organizations need to develop information gathering capability to cope with uncertainty and dynamism in their external business environment (Aguilar, 1967; Albright, 2004; Daft and Lengel, 1986; Hambrick, 1982). Accordingly, we view ES as an information gathering capability.

Uncertainty, as a central concept in OIPT, drives the need for developing an information processing capability (Gattiker and Goodhue, 2004; Goodhue *et al.*, 1992; Smith *et al.*, 1991). OIPT has been applied as a theoretical lens to examine supply chain sustainability (Busse *et al.*, 2017; Fabbe-Costes *et al.*, 2014), SCI (Srinivasan and Swink, 2015; Swink and Schoenherr, 2015; Williams *et al.*, 2013; Wong *et al.*, 2011; Yu *et al.*, 2013) and responses to supply chain disruptions (Bode *et al.*, 2011). SCI acts as the information processing capability in a focal firm and its suppliers/customers to systematically identify, gather and analyze external environmental information (Bode *et al.*, 2011; Srinivasan and Swink, 2015). Information sharing among supply chain partners (Huo *et al.*, 2014; Williams *et al.*, 2013) can help reduce information needs. To better coordinate and manage material and information flows across the entire supply chain, firms use strategic collaboration (SCI) for gathering, sharing and analyzing information regarding upstream, internal and downstream supply chain operations and activities (Hult *et al.*, 2004; Huo *et al.*, 2014; Jacobs *et al.*, 2016; Williams *et al.*, 2013). Thus, SCI can act as an information processing mechanism at a supply chain level, involving several supply chain actors.

OIPT can be used to explain the relationship between SCI and SCR but its explanation is restricted to the ability of SCI to reduce strategic uncertainty through information sharing and alignment with suppliers (Danese *et al.*, 2013). OIPT focuses on linking uncertainty with information needs and information processing capacity and prescribe organizational designs to reduce uncertainty and information needs (Galbraith, 1973). However, OIPT does not focus on the ability to gather and interpret information (such as signals from ES) and how firms incorporate the information into their strategic actions. Thus, OIPT alone cannot fully explain the links between ES and performance.

3. Conceptual framework and research hypotheses

To supplement the OIPT and better explain the roles of SCI and SCR in transforming ES signals into operational performance, this study introduces the SIAP model proposed by Thomas *et al.* (1993) to the supply chain literature. The model was initially developed to understand how managers and organizations deal with potentially significant information. It is argued that organizations adapt to the environment through three processes: scanning, interpreting and responding (Milliken, 1990). Similarly, strategic sense-making activities performed by executives often involve reciprocal interaction of information seeking, meaning ascription and action (Gioia and Chittipeddi, 1991). Thomas *et al.* (1993) further argue each sense-making process could affect performance.

Scanning involves information gathering through identification of events or issues from the external and internal environments that might affect an organization (Ebrahimi, 2000; Thomas *et al.*, 1993). The SIAP model suggests that “scanning” is a crucial first step in organizational adaptation to the environment through its role as an antecedent to interpretation and action (Aguilar, 1967; Hambrick, 1981; Thomas *et al.*, 1993). Scanning is often performed by top executives who are frequently provided more information than they can process (Mintzberg, 1973). Among this information weak signals, which are crucial for strategic insight, are difficult to identify (Daft *et al.*, 1988). Thus, information specificity is key to scanning effectiveness (Choudhury and Sampler, 1997).

Interpretation involves the development or application of methods for comprehending the meaning of information supporting decisions related to strategic actions (Thomas *et al.*, 1993). At an individual or group level, managers use various schema as information processing mechanisms to interpret and label information (Gioia and Chittipeddi, 1991). During this process managers may categorize incoming information about an object, event, or issue as an “opportunity,” “problem” or “threat” (Dutton and Duncan, 1987) which will subsequently effect the level of risk-taking, involvement and commitment associated with a given strategic decision or action (Kahneman and Tversky, 1984). Since there is a need to align across suppliers and customers (Skipworth *et al.*, 2015) with the environment (Beal, 2000; Bourgeois, 1980), we argue focal firms should develop a shared schema with key suppliers and customers by using SCI – defined as strategic collaboration (Flynn *et al.*, 2010; Wong *et al.*, 2011) – as an inter-organizational information processing mechanism.

Action is referred to as strategic changes implemented by organizations adapting to the environment; they can range from minor changes in procedures, to significant changes in product and market strategies and the redesign of organizational structures (Dutton and Duncan, 1987). Owing to the dependency between a firm and its suppliers and customers, we argue the implementation of supply chain strategies acts as a key organizational action. In practice, organizational actions can be generated based on information gathered from the environment with or without substantial interpretation thereof. However, the lack of an ability to align organizational actions with the environment using information from the environment could lead to compromised performance (Thomas *et al.*, 1993). In the present study, SCR is treated as a strategic action for responding to a changing environment.

Performance is the last component of the SIAP model. Researchers seek to attribute differences in the performance of similar organizations to differences in their ability to carry out the scanning, interpretation and action activities (Thomas *et al.*, 1993). Since executives often lack a process for assessing the effects of their scanning and interpretation activities, or the associated actions on a performance in practice, an important role of academic researchers is to collect and analyze data about each element of the SIAP model to better inform the practice. One of the issues debated concerns the possible direct and indirect effects of scanning and interpretation processes (Thomas *et al.*, 1993). One stream of literature argues performance depends greatly on a rational thought process, which involves active information processing and systematic sequential execution of the scanning, interpretation and action processes (Thomas *et al.*, 1993). In contrast, other scholars argue for a less deliberate approach to sense-making (interpretation) and that managers may simply refer to the outcomes of past actions to inform the next action without scanning and/or interpreting information from the environment (Weick, 1979). To interpret the performance implications for organizations, we therefore need a comprehensive understanding of the detailed linkages among scanning, interpretation, action and performance (Daft *et al.*, 1988).

Figure 1 illustrates a proposed conceptual model to link ES, SCI, SCR and performance following the SIAP model (Thomas *et al.*, 1993). We chose operational performance as the “P” in the SIAP model. Operational performance is a composite measure of volume flexibility, delivery performance, inventory cost and product quality (e.g. Flynn *et al.*, 2010; Huo *et al.*, 2014). It is commonly used in the strategy literature to explain effects of ES (Thomas *et al.*, 1993). It could be indirectly affected by SCI (Flynn *et al.*, 2010; Swink *et al.*, 2007) and ES (Thomas *et al.*, 1993). Demonstrating the effects of SCI and SCR on operational performance helps justify the strategic value of such SCM practices in supporting the efforts by executives to capitalize on weak signals. Six hypotheses (H1–H6) are developed to accommodate all possible direct and indirect paths.

3.1 The role of ES

ES serves as the “S” and first sequence in the SIAP model (Thomas *et al.*, 1993). ES can provide information about changes to supply and/or demand and thus serves as a prerequisite for strategic flexibility and responsiveness. ES enables firms to perceive external events and

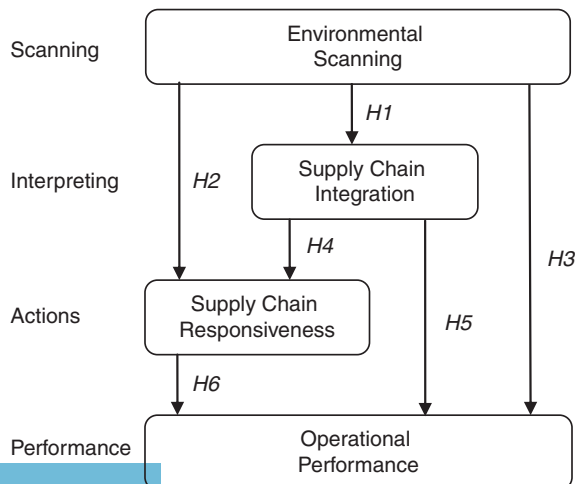


Figure 1.
Proposed
conceptual model

trends that threaten its existence or offer business opportunities to exploit, and to identify the necessary capabilities or skills to be able to effectively adapt to a changing business environment (Beal, 2000; Castanias and Helfat, 2001). In a supply chain context, to develop an integrated and responsive supply chain, firms need to gather information from the business environment, e.g., information about forecasting sales and customer preferences, supply markets and other trading members.

The ES literature suggests that effectively identifying, gathering and analyzing information about events and trends occurring outside the firm is integrally linked to organizational and strategic planning as well as planning for unexpected changes in environmental conditions (Aguilar, 1967; Albright, 2004; Hambrick, 1982; Hough and White, 2004). Since SCI processes entail information sharing (Chavez *et al.*, 2015) they can act as an information processing mechanism in the OIPT sense (Zsidisin *et al.*, 2015). Information from the external environment is processed and used to develop and coordinate strategic collaboration and helps firms be responsive in dynamic and competitive environments (Hult *et al.*, 2004; Huo *et al.*, 2014). In a supply chain context, we argue that the information gained from scanning the external environment, e.g., new technologies, new markets and best practices, can be acted upon to improve supplier selection and customer satisfaction. The information can be used to build long-term strategic collaborations with supply chain partners which in turn could lead to the supply chain becoming more responsive to market dynamics and customer needs (Albright, 2004; Koufteros *et al.*, 2012).

From an OIPT perspective, SCI can be viewed as the formulation of a strategic collaboration where supply chain partners share information and resources (Flynn *et al.*, 2010); strategic collaboration being made possible when there is a common schema to interpret information from the environment (Wong *et al.*, 2011). For example, a manufacturer may share its inventory planning and demand forecasts with suppliers and/or its customers may share point of sale information and related market information (Huo *et al.*, 2014). The result is that more insight and coordinated actions can be achieved when the trading partners jointly interpret information related to forecasting sales, customer preferences, supply markets and new technologies. As such ES acts as an information gathering device to inform and facilitate SCI activities such as supplier involvement in product development (Koufteros *et al.*, 2005), joint decision making (Scheonherr and Swink, 2012), or supplier performance improvement (Sanders *et al.*, 2011). SCI activities increase information processing capacity by involving suppliers and customers in the supply chain planning process with the aim being to more accurately respond to changes in the market.

The SIAP model considers the possibility that scanning “S” directly affects action “A,” especially for highly familiar environmental information (Thomas *et al.*, 1993). Accurate and credible information increases the ability of the supply chain to react effectively to changes through coordinated actions (Chavez *et al.*, 2015). Through ES, firms can also quickly respond to changes in the needs of the market, strategies of competitors and new technologies. In stable environments ES can be beneficial to firms for responding to new opportunities before competitors. Additionally, ES can help explain demand unpredictability, such that supply chain managers can develop accurate supply chain strategies. Similarly, from an OIPT perspective SCR can be viewed as a strategy that enables firms to react and adapt to the changes in demand and supply (Williams *et al.*, 2013) by interpreting external business environments and using responsiveness to adapt to changes in market dynamics (Albright, 2004; Huo *et al.*, 2014). Therefore, we expect a significant effect of ES on SCI and SCR:

H1. ES has a significant positive effect on SCI.

H2. ES has a significant positive effect on SCR.

Previous research has suggested that effective scanning of the business environment provides a firm with current and valuable information, which influences a firm’s ability to

align its competitive strategy with its external business environment (Beal, 2000; Yasai-Ardekani and Nystrom, 1996). According to OIPT, information has become an important resource for firms to enhance organizational competitiveness (Bergeron, 2000; Swink and Schoenherr, 2015; Williams *et al.*, 2013). The development of ES capability is important for firms to survive and prosper in a dynamic and competitive market by quickly adapting strategy and structure (Yasai-Ardekani and Nystrom, 1996). Similarly, in more stable industries ES should be established to ensure the most accurate and cost-efficient transmission of information (Lee, 2002). Through effective scanning of the business environment firms can better identify external events and trends that threaten their existence or offer opportunities to exploit, which then become inputs for strategic decisions that deliver operational and financial benefits to the firms (Ahituv *et al.*, 1998; Beal, 2000; Castanias and Helfat, 2001). Our argument is grounded in OIPT's notion that ES provides a firm the capacity to achieve superior performance (Ahituv *et al.*, 1998). Other than the capacity of SCI and SCR to minimize supply chain disruption due to unanticipated changes in the business environment (Fabbe-Costes *et al.*, 2014), there are other capabilities that can respond to new signals or changes in the market. For example, portfolio breadth (Closs *et al.*, 2008; Jacobs, 2007), new product design and development (Koufteros *et al.*, 2005) and production process design (Jacobs *et al.*, 2011) all benefit from external information. While these other means are not included into our model for parsimony and clarity reasons, we argue that ES may directly deliver operational performance:

H3. ES has a significant positive effect on operational performance.

3.2 The role of SCI

According to OIPT, to respond to increasing environmental uncertainty and dynamism firms need to gather and process more and better information to increase responsiveness in supply chains (Daft and Lengel, 1986; Williams *et al.*, 2013). SCI involves long-term strategic collaboration where supply chain partners can share goals, information and resources (Flynn *et al.*, 2010; Wong *et al.*, 2011; Yu *et al.*, 2013) through a shared schema. Following the argument of Daft and Weick (1984) that organizations act as interpretation systems, the use of shared goals and schema through SCI represents another form of an inter-organizational interpretation system. Thus, SCI is regarded as the "I" in the SIAP model.

Our arguments are grounded in the SIAP model and OIPT's tenet that effective interpretation of information by supply chain partners helps the supply chain to become more responsive (Williams *et al.*, 2013; Wong and Hvolby, 2007). Without the ability to quickly and effectively respond to changes in demand and supply (Williams *et al.*, 2013), opportunities and threats identified by ES cannot be exploited or mitigated. In an integrated supply chain firms can share and jointly utilize high-quality information about demand and supply conditions from supply chain partners. Such integration is deemed to be an important prerequisite to a SCR capability (Holsapple and Jones, 2005; Williams *et al.*, 2013). SCI provides insights from the environment as the basis for quickly and effectively responding to the rapidly changing business environment (Flynn *et al.*, 2010; Huo *et al.*, 2014; Wong *et al.*, 2011). Accordingly, we expect that SCI acts as an important enabler of SCR:

H4. SCI has a significant positive effect on SCR.

Researchers have long articulated the important role of SCI in improving firm performance (e.g. Flynn *et al.*, 2010; Huo, 2012; Jacobs *et al.*, 2007; Ralston *et al.*, 2015; Yu, 2015; Yu *et al.*, 2013) and it has been argued that SCI affects firm performance through the creation of operational competitive advantages (Swink *et al.*, 2007). Consistent with the fundamental principle of OIPT, we expect that information processing capability afforded by SCI leads to

better operational performance (Wong *et al.*, 2011). In an integrated supply chain, building long-term strategic partnerships with customers and suppliers will facilitate strategic collaboration such as the better understanding of customer requirements, reduction of uncertainty and equivocality, better forecasting of customer demand and collaboration in planning and joint product development with suppliers, which will, in turn, enable firms to more flexibly produce and deliver better quality products/services at lower cost (Flynn *et al.*, 2010; Wong *et al.*, 2011) with better delivery performance (Danese *et al.*, 2013). The SIAP model argues the link between “T” and “P” (Thomas *et al.*, 1993) because interpretation is used to enact or confirm the validity of a strategy, as well as to create competitive performance in delivery speed, inventory cost reduction and volume flexibility. We therefore expect a positive link between SCI and operational benefits:

H5. SCI has a significant positive effect on operational performance.

3.3 The role of SCR

A supply chain strategy can be formulated after gathering environmental information via ES and sharing insights with supply chain partners via SCI. The SCR strategy, regarded as action or the “A” in the SIAP model, must be implemented in a timely manner congruent with changes in the business environment. SCR has been viewed as an organizational capability enabling firms to achieve competitive advantage (Gunasekaran *et al.*, 2008; Wang and Wei, 2007; Williams *et al.*, 2013; Yu *et al.*, 2018) and is chosen for this study because time is a key factor for responding to emerging risk from a changing environment and responsiveness is a key component of time-based competitiveness (Stalk and Hout, 1990). Previous research has suggested that SCR enables firms to quickly respond to changes in an uncertain environment (Kim and Lee, 2010; Williams *et al.*, 2013; Yu *et al.*, 2018), which is likely to result in improving product and volume flexibility, providing fast and reliable delivery and producing high quality products meeting customer needs. By collaborating with supply chain partners to respond to market changes, a focal firm can gain operational benefits because its supply chain becomes more aligned with its external environment (Kim and Lee, 2010; Qrunfleh and Tarafdar, 2013; Wu *et al.*, 2006). Therefore, based on the extant literature, we argue that developing a responsive supply chain enables firms to improve operational performance:

H6. SCR has a significant positive effect on operational performance.

4. Research methodology

4.1 Sample and data collection

Survey data were collected from China’s manufacturing industry between June 2014–January 2015. A total of five regions representing different stages of economic development in China were chosen as the sample pool including Pearl River Delta, Yangtze River Delta, Bohai Sea Economic Area, Central China and Southwest China. We used the China Enterprises Directory as the starting point for identifying potential participants. To obtain a representative sample, we randomly selected 1,500 manufacturing firms from the China Enterprises Directory across the five regions. For each randomly selected manufacturer, we identified a key informant, who typically held a managerial position such as CEO, president, director, or general manager and was knowledgeable about the firm’s supply chain process (Flynn *et al.*, 2010). We contacted key informants ($n = 1,500$) by telephone and e-mail in order to obtain their preliminary agreement to participate in this research. We identified key informants with the help of part-time research assistants (e.g. undergraduate and postgraduate students) and guanxi networks (e.g. personal connections with manufacturing firms, industrial authorities and local universities). Previous research

has suggested that accessing personal guanxi networks is a useful tool to ensure success in collecting survey data in China (Yu *et al.*, 2014; Zhao *et al.*, 2006). Most of the informants had been in their current position for more than five years. Thus, based on position and tenure it is reasonable to expect that the informants had sufficient knowledge to complete the survey (Zhao *et al.*, 2006). The questionnaires and a cover letter explaining the main purpose of the study and assuring confidentiality were sent to 1,230 firms that agreed to participate and provide information for this research. After several telephone and e-mail reminders a total of 337 questionnaires were received. Eight returned questionnaires were discarded because of significant missing data leaving 329 completed and useable questionnaires. Even though previous studies in the Chinese context have indicated that it is difficult to obtain a high response rate to surveys, especially when targeting multiple regions of China (Zhao *et al.*, 2006), the effective response rate was 26.75 percent. Table I provides a summary of demographic characteristics of respondents. Part of the survey data were published in Yu *et al.* (2017) whereby marketing and IT capabilities as antecedents of the SCI construct were examined and in Yu *et al.* (2018) whereby SCI and SCR as two dimensions of data-driven supply chain capabilities and their effects on financial performance were examined. The roles of SCI and SCR in linking ES and operational performance examined in the present study extend the previous two papers (Yu *et al.*, 2017, 2018).

4.2 Questionnaire design and measures

Following previous guidance (e.g. Flynn *et al.*, 2010; Yu *et al.*, 2013; Zhao *et al.*, 2011) the English version of the questionnaire was developed and then translated it into Chinese. This was followed by a back-translation to ensure conceptual equivalence. We checked the back-translated English version against the original English version to assure the reliability of the questionnaire. A number of questions were reworded in minor ways to improve the accuracy of the translation and relevance to cultural and business practices in China (Zhao *et al.*, 2006). Even though the measurement scales were used prior and demonstrated to be valid we took extra steps before administering the survey. Content validity was established through a comprehensive analysis of the relevant literature, iterative construct review and a

	Percent (%)		Percent (%)
Industries		Respondent location	
Automobile	34.3	Pearl river delta ^a	5.2
Chemicals and petrochemicals	15.2	Yangtze river delta	10.0
Electronics and electrical	7.9	Bohai sea economic area	6.6
Fabricated metal product	2.4	Central China	8.2
Food, beverage and alcohol	2.7	Southwest China	69.9
Rubber and plastics	4.0	Annual sales (in million Yuan)	
Textiles and apparel	33.4	Below 10	10.9
Number of employees		10–50	16.1
1–100	17.0	50–100	13.4
101–200	10.9	100–500	17.0
201–500	19.8	500–1,000	7.9
501–1,000	8.2	Above 1,000	34.7
1,001–3,000	16.4	Firm age (years)	
> 3,000	27.7	≤ 10	31.3
Years in current position		11–20	31.6
≤ 5	41.3	21–30	10.6
6–10	30.7	> 30	26.4
> 10	28.0		

Table I.
Demographic
characteristics of
respondents

Notes: $n = 329$. ^aThe sample includes one firm in Taiwan and one firm in Hong Kong

pilot test with academic and industrial experts (Flynn *et al.*, 2010; Zhao *et al.*, 2011). To assess the content validity of the scales we consulted three academic experts on the basis of their research and consulting activities. Further, we conducted a pilot test with five randomly selected manufacturers using semi-structured interviews. Based on the feedback, redundant and ambiguous items were eliminated or modified in minor ways.

The measurement items used in this study were adopted from the literature and are reported in Table II. The measures for ES were adopted from Barringer and Bluedorn (1999) and Miller and Friesen (1982) and focus on gathering information about business environment from clients and suppliers and other channel members, through explicit tracking of the policies and tactics of competitors, forecasting sales and customer preferences and special marketing research studies. A seven-point scale was used, ranging from 1 “not ever used” to 7 “used extremely frequently.”

The measures for SCI and SCR were adopted from Wu *et al.* (2006). We measured SCI using five items: developing strategic plans in collaboration with partners, collaborating actively in forecasting and planning with partners, planning future demand collaboratively

Measurement items	Factor loadings	t-values	α	CR	AVE
1. Environmental scanning			0.862	0.864	0.562
Routine gathering of opinions from clients	0.772	–			
Explicit tracking of the policies and tactics of competitors	0.812	14.744			
Forecasting sales and customer preferences	0.773	14.013			
Special marketing research studies	0.754	13.640			
Gathering of information from suppliers and other channel members	0.622	11.039			
2. Supply chain integration			0.944	0.944	0.772
Our company develops strategic plans in collaboration with our partners	0.900	–			
Our company collaborates actively in forecasting and planning with our partners	0.921	26.951			
Our company projects and plans future demand collaboratively with our partners	0.899	25.377			
Collaboration in demand forecasting and planning with our partners is something we always do in our company	0.837	21.516			
Our company always forecasts and plans activities collaboratively with our partners	0.832	21.284			
3. Supply chain responsiveness			0.940	0.943	0.767
Compared to our competitors, our supply chain responds more quickly and effectively to changing customer and supplier needs	0.878	–			
Compared to our competitors, our supply chain responds more quickly and effectively to changing competitor strategies	0.934	26.058			
Compared to our competitors, our supply chain develops and markets new products more quickly and effectively	0.835	20.546			
In most markets, our supply chain is competing effectively	0.887	23.202			
The relationship with our partner has increased our supply chain responsiveness to market changes through collaboration	0.840	20.761			
4. Operational performance			0.865	0.880	0.565
Rapidly change production volume	0.576	–			
Deliver products quickly or short lead-time	0.886	11.548			
Provide on-time delivery to our customers	0.900	11.640			
Provide reliable delivery to our customers	0.925	11.795			
Produce consistent quality products with low defects	0.607	9.066			
Produce products with low inventory costs	0.488	7.682			

Table II. Notes: Model fit statistics: $\chi^2 = 601.136$; $df = 183$; $\chi^2/df = 3.285$; RMSEA = 0.083; CFI = 0.927; IFI = 0.928; CFA results: reliability and validity TLI = 0.917; SRMR = 0.077

with partners, collaboration in demand forecasting and planning with partners and forecasting and planning activities collaboratively with partners. Collaborative forecasting and planning involve a significant amount of joint data interpretation; thus, SCI is treated as "T" in the SIAP model (Thomas *et al.*, 1993). The measurement items for SCR include responding more quickly and effectively to changing customer and supplier needs, responding more quickly and effectively to changing competitor strategies, developing new products more quickly and effectively and increasing SCR to market changes through collaboration. SCR is positioned as a deliberate strategic action, "A" in the SIAP model (Thomas *et al.*, 1993), implemented by the supply chain. All these items were measured using a seven-point scale from 1 (strongly disagree) to 7 (strongly agree).

The perceptual measures for operational performance were adapted from the SCM literature (e.g. Flynn *et al.*, 2010; Huo *et al.*, 2014; Wong *et al.*, 2011) and include volume flexibility, delivery performance, inventory cost and product quality, which have been widely used in previous research. Conducting empirical research collecting objective performance data can be very challenging in China, partly because there is little incentive for respondents to provide researchers with accurate accounting data (Zhao *et al.*, 2006). Therefore, consistent with previous empirical studies (e.g. Flynn *et al.*, 2010; Wong *et al.*, 2011) perceptual performance data were used in this study. Respondents were asked to evaluate relative competitive performance over the past three years by comparisons with their main competitors in the industry. The indicators were measured using a seven-point scale, from 1 "much worse than your major competitors" to 7 "much better than your major competitors."

We used three control variables in the conceptual model, including firm size, firm age and industry type. Firm size, measured by the number of employees (see Table I), was used as a control because larger firms may have more resources for managing supply chain activities in dynamic business environments and thus may achieve better operational performance than small firms (Huo *et al.*, 2014; Yu *et al.*, 2013). Firm age, measured by the number of years since firm foundation, was controlled because it might be related to performance as older firms might be more likely to overcome performance-threatening liabilities (Yu *et al.*, 2013). Industry type was controlled because firms in differing manufacturing industries may develop different levels of SCI and SCR for performance improvement. We used a dummy variable for industry types. The dummy variable Industry 1 refers to automobile, Industry 2 refers to chemicals and petrochemicals, Industry 3 refers to electronics and electrical and Industry 4 refers to textiles and apparel. As shown in Table I, they are the four largest manufacturing industries in this study. The base group is other industries (Huo *et al.*, 2014).

4.3 Non-response bias and common-method bias

We assessed non-response bias using the method recommended by Armstrong and Overton (1977) comparing early and late respondents on two important demographic variables (i.e. annual sales and number of employees). The *t*-test results indicate no significant statistical difference ($p < 0.05$) among the category means for number of employees and sales suggesting that non-response bias is unlikely to be a concern in this study. It would be ideal to compare non-responders to responders to check for bias, but we were not able to track down enough information about non-respondents and therefore are not able to compare them with respondents. This is a limitation that is common for survey-based studies.

We assessed common method bias because we gathered data from a single respondent per firm using the self-reported questionnaire survey (Podsakoff *et al.*, 2003). Harman's single-factor test is arguably the most widely known approach for assessing common method bias in a single-method research design (Podsakoff *et al.*, 2003). Previous research has argued that Harman's single-factor test does not eliminate the possibility of common

method bias (Podsakoff *et al.*, 2003). We therefore tested common method bias using two approaches. First, confirmatory factor analysis (CFA) was applied to Harman’s single-factor model in order to further evaluate common method bias. The CFA generated an unacceptable model fit of χ^2/df (2,141.356/189) = 11.330, CFI = 0.661, IFI = 0.663, TLI = 0.624, RMSEA = 0.177 and SRMR = 0.122 (Hair *et al.*, 2010; Hu and Bentler, 1999) significantly worse than those of the measurement model (see Table II). Second, to further assess common method bias two measurement models were tested and compared; one model including only the traits and the other model including both the traits and a latent factor (Flynn *et al.*, 2010; Podsakoff *et al.*, 2003; Yu *et al.*, 2013; Zhao *et al.*, 2011). This approach provides a further assessment of common method bias. The results indicate that the model with a latent factor changed inconsequentially (CFI by 0.003, IFI by 0.002 and TLI by 0.008). While the above tests suggest common method variance bias is unlikely to be a problem in this study, we acknowledge that these tests are not confirmatory in nature.

5. Data analysis and results

5.1 Measurement model

We performed relevant analyses to assess the unidimensionality, reliability and validity (discriminant and convergent validity) of the theoretical constructs (Fornell and Larcker, 1981; Gerbing and Anderson, 1988; O’Leary-Kelly and Vokurka, 1998). The results are reported in Tables II and III.

We conducted a CFA to assess the unidimensionality of scale items (Gerbing and Anderson, 1988). The CFA results reported in Table II indicate that the measurement model has a good fit (χ^2/df = 3.285; RMSEA = 0.083; CFI = 0.927; IFI = 0.928; TLI = 0.917; and SRMR = 0.077) (Hair *et al.*, 2010; Hu and Bentler, 1999), which suggests unidimensionality.

We computed Cronbach’s α and composite reliability (CR) to assess reliability. Table II indicates that Cronbach α and CR values of all theoretical constructs were well above the acceptable threshold of 0.70 (Hair *et al.*, 2010). The results therefore provide evidence of reliability.

As shown in Table II, the measurement model suggests that all indicators in their respective constructs have statistically significant ($p < 0.001$) factor loadings greater than 0.50 (only one item with a loading slightly below 0.50) and that all t -values were greater than 2, thus demonstrating convergent validity (Hair *et al.*, 2010; Hu and Bentler, 1999; O’Leary-Kelly and Vokurka, 1998). Additionally, all of the average variance extracted (AVE) values were greater than the acceptable threshold of 0.50, which provides further evidence of convergent validity (Fornell and Larcker, 1981).

Following the approach recommended by Fornell and Larcker (1981), we assessed discriminant validity by comparing the square root of the AVE for each construct with the correlations with all other constructs in the model. As shown in Table III, the square root of every AVE for each construct is much larger than any correlation among any pair of latent constructs, which provides evidence of discriminant validity (Fornell and Larcker, 1981).

	Mean	SD	ES	SCI	SCR	OP
Environmental scanning (ES)	5.373	1.016	0.749 ^a			
Supply chain integration (SCI)	4.661	1.266	0.428**	0.879		
Supply chain responsiveness (SCR)	4.660	1.269	0.441**	0.811**	0.876	
Operational performance (OP)	5.129	0.989	0.405**	0.548**	0.606**	0.752

Notes: ^aSquare root of AVE is on the diagonal. **Correlation is significant at the 0.01 level (two-tailed)

Table III.
Descriptive statistics

5.2 Results

We tested the proposed theoretical framework (Figure 1) using structural equation modeling (SEM). The structural model has a good fit (Hair *et al.*, 2010; Hu and Bentler, 1999) and the results are reported in Table IV and Figure 2. Although firm size, firm age and industry type

802

Structural paths	Standardised coefficient	t-values	Hypothesis test
Environmental scanning → Supply chain integration	0.459***	7.637	H1: supported
Environmental scanning → Supply chain responsiveness	0.103*	2.525	H2: supported
Environmental scanning → Operational performance	0.139*	2.234	H3: supported
Supply chain integration → Supply chain responsiveness	0.805***	16.304	H4: supported
Supply chain integration → Operational performance	0.072	0.677	H5: not supported
Supply chain responsiveness → Operational performance	0.404***	3.589	H6: supported
<i>Control variable</i>			
Firm size → Operational performance	-0.061	-1.066	
Firm age → Operational performance	0.076	1.327	
Industry type 1 → Operational performance	0.020	0.235	
Industry type 2 → Operational performance	-0.086	-1.184	
Industry type 3 → Operational performance	-0.058	-0.925	
Industry type 4 → Operational performance	-0.094	-1.108	
Variance explained (R^2)	R^2		
R^2 Supply chain integration	0.211		
R^2 Supply chain responsiveness	0.734		
R^2 Operational performance	0.333		

Table IV.
Results of hypothesis test using SEM

Notes: Model fit statistics: $\chi^2 = 810.611$; $df = 297$; $\chi^2/df = 2.729$; RMSEA = 0.073; CFI = 0.920; IFI = 0.921; TLI = 0.905; SRMR = 0.075. * $p < 0.05$; *** $p < 0.001$;

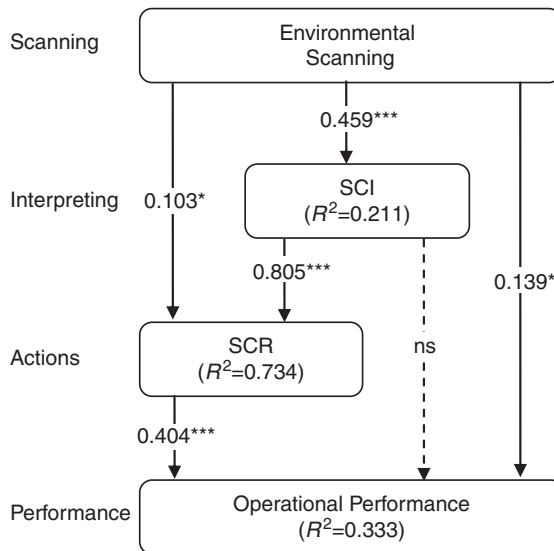


Figure 2.
Model estimation results

Notes: Fit index: $\chi^2/df = 2.729$; RMSEA = 0.073; CFI = 0.920; IFI = 0.921; TLI = 0.905; SRMR = 0.075; * $p < 0.05$; *** $p < 0.001$

were each included as a control variable in the structural model; none had a significant effect on operational performance. The structural model reveals that ES is positively and significantly related to SCI ($\beta = 0.459, p < 0.001$), SCR ($\beta = 0.103, p < 0.05$), and operational performance ($\beta = 0.139, p < 0.05$), thus lending support for *H1–H3*. The SEM also demonstrates that SCI has a significant positive effect on SCR ($\beta = 0.805, p < 0.001$) and that SCR is positively and significantly associated with operational performance ($\beta = 0.404, p < 0.001$). Hence, we find support for *H4* and *H6*. However, there is no statistically significant relationship between SCI and operational performance ($\beta = 0.072, ns$). Thus, *H5* is rejected.

As depicted in Figure 2, we found that ES and SCI affect operational performance through SCR. To identify the extent of the mediating effect of SCR we used a bootstrap approach as it is considered a more powerful approach than the causal steps approach popularized by Baron and Kenny (1986) for estimating mediation and indirect effects (Preacher, 2015; Zhao *et al.*, 2010). Specifically, we used bias-corrected bootstrapping with 10,000 resamples to estimate indirect effects and their significance. Table V presents the results of the mediation analysis using estimates of direct and indirect paths.

The bootstrap results indicate that the direct effect of SCI on operational performance is not significant ($\beta = 0.072, ns$). However, the indirect effect of SCI on operational performance via SCR is positive and significant ($\beta = 0.325, p < 0.01$; 95% confidence interval: lower bounds = 0.116, upper bounds = 0.554). The results suggest that SCR acts as a full mediator of the ES–operational performance relationship. Table V indicates that ES has a significant direct effect on operational performance ($\beta = 0.139, p < 0.10$), and that the indirect effect of ES on operational performance through SCR is also significant and positive ($\beta = 0.224, p < 0.001$; 95% confidence interval: lower bounds = 0.145, upper bounds = 0.322). The results indicate that SCR partially mediates the relationship between ES and operational performance.

6. Discussion and implications

6.1 Theoretical implications

This study provides several original theoretical implications for the interpretation of the relationship between ES, SCI, SCR and firm performance. First, we address a common problem facing strategic management and SCM researchers, i.e., the lack of an integrative and comprehensive framework to understand complex relationships among several constructs, especially constructs from other disciplines. For example, more complex sequential effects of SCI have been recognized (Kim and Lee, 2010; Sanders, 2007) but progress in SCI research is largely limited to the use of contingency and configuration theories (Flynn *et al.*, 2010; Wong *et al.*, 2011). Using the SIAP model (Thomas *et al.*, 1993), this study integrates knowledge from the literatures of strategic management and SCM to reveal the strategic roles of SCI and SCR. While the strategic management literature attempts to explain the performance effects of ES (Beal, 2000; Garg *et al.*, 2003), the roles of SCM practices in facilitating supply-chain – wide interpretation capacity and strategic

Structural paths	Direct effect	Indirect effect	SE of indirect effect	95% CI for indirect effect	Result
ES→SCR→OP	0.139***	0.224***	0.044	0.145–0.322	Partial mediation
SCI→SCR→OP	0.072	0.325**	0.111	0.116–0.554	Full mediation

Notes: ES, environmental scanning; SCR, supply chain responsiveness; SCI, supply chain integration; OP, operational performance; SE, bootstrap standard error; CI, bootstrap confidence interval; Standardized effects; 10,000 bootstrap samples. ** $p < 0.01$; *** $p < 0.001$; **** $p < 0.10$

Table V.
Results of
bootstrapping
test for mediation

response are often not captured in theoretical models. On the other hand, the SCM literature addressing the effects of various SCM practices using resource-based view or the like cannot fully explain the mechanisms in which SCI and SCR support strategy processes such as ES to generate operational advantages. The SIAP model can be used to understand the effects of other SCM practices, as long as scanning of environmental information and interpretation of the data is involved to develop an adaptive strategy.

The second implication concerns the application of OIPT. OIPT has been useful in explaining the differing information processing mechanisms for coping with environmental complexity (Flynn and Flynn, 1999) and the distinct roles of internal and external integration (Scheonherr and Swink, 2012; Wong *et al.*, 2011). However, never before has the field systematically divided information gathering and information interpretation while linking them to the supply chain strategy process. Information processing in a supply chain context is not new (Flynn and Flynn, 1999), but its wider application for explaining the SIAP model is new. As mentioned, OIPT could be expanded to encompass a supply chain level analysis. Nair *et al.* (2016) have explored the roles of environmental sensing in a supply network level. When the SIAP model is applied at the supply chain level it allows us to extend OIPT beyond the boundaries of the firm to consider how multiple supply chain actors gather, interpret and apply information to deal with uncertainty in the external environment. This extended perspective of OIPT helps explain how the scanning for and interpretation of information across supply chain partners, and then integrated and coordinated action, leads to enhanced firm and supply chain performance.

This study expands the role of SCI from an OIPT perspective. Prior to this study SCI was considered to play information sharing and coordination roles to improve SCR through uncertainty reduction (Danese *et al.*, 2013), but the “joint interpretation” roles of SCI to reduce equivocality is a novel perspective added. As such, by positioning SCI as “interpretation” we can explain a related “action” such as SCR and fill the gaps between ES and performance. While studies using OIPT have focused on uncertainty reduction, we extend knowledge of alternate information processing mechanisms (Flynn and Flynn, 1999) for reducing equivocality offered by SCI, to better explain the significance of SCI in creating shared meanings and joint goals despite the potential use of different frames to interpret the environment.

The third implication concerns the opportunity to expand the SIAP model to better explain the ES–SCI–SCR–performance relationships. The strategy literature acknowledges executives base their interpretation of outcomes on the environment to devise new scanning strategies (Thomas *et al.*, 1993). That means the environment is a trigger of scanning activities that could be added to the SIAP model, thus leading to a more comprehensive SIAP model. The strategy literature acknowledges the need for ES at different hierarchical levels but not at a supply chain level. This study reveals the importance of jointly interpreting ES signals with supply chain partners through SCI to devise joint actions to respond to environmental changes (SCR as a supply chain-wide strategy). Thus, theories applying the SIAP model can be extended from the firm to the supply chain level. Nevertheless, our findings suggest that SCI and SCR are crucial but not the only explanatory factors for operational performance. Therefore, there could be other constructs that represent SIAP models. ES is not the only channel of external environmental information and other SCM practices (such as supply chain innovation, supply chain resilience and supply chain sustainability) require external input to ultimately affect performance. This implies a wealth of new research opportunities. On the other hand, frameworks such as the strategy–structure–performance (SSP) might also be used to explain firm performance from a structural perspective (e.g. Chen *et al.*, 2009; Chow *et al.*, 1995), even though the “strategy” here might have to consider ES and other sources of strategic insights.

The fourth implication can also be viewed as a refinement and extension of SCI research. Although previous studies have investigated the relationship between SCI and firm performance, these studies have generated inconsistent results (Flynn *et al.*, 2010; Yu, 2015). The mixed support in the SCI literature indicates that further investigation is needed to explore the SCI–performance relationship. Our results reveal that there is no significant direct relationship between SCI and operational performance, which is consistent with that reported in several previous studies (Flynn *et al.*, 2010; Yu, 2015). While the existing findings may suggest SCI plays little strategic role, our findings demystify such claims. Our study identifies the strategic roles of SCI on SCR in transforming weak signals into competitive performance. Thus, the present study extends the work of Yu *et al.* (2018) by investigating the mediating role of SCR from an OIPT perspective. The implication of the SIAP model is that SCI and SCR can be classified as a hierarchical sequence, one after another, in the strategic foresight and actions process. Previous SCM studies (e.g. Yu *et al.*, 2018) have not recognized such crucial strategic roles of SCI. Hence, future research may treat SCI as an interpretation process for achieving shared meaning and goals, from the OIPT perspective, to uncover other supply chain strategies that mediate the SCI–performance relationship (Kim and Lee, 2010; Wu *et al.*, 2006; Yu *et al.*, 2018).

The final important theoretical implication informs the strategic planning literature. We found that the effect of ES on firm performance is partially mediated by the development of responsiveness in supply chains. Although previous research has addressed the importance of ES in the strategic planning process (Albright, 2004; Fabbe-Costes *et al.*, 2014), to the best of our knowledge no previous study has investigated the effect of ES on operational performance in the supply chain context. Our study is an initial attempt at filling the aforementioned gaps in the literature. More specifically, our study suggests that a more refined and nuanced explanation of the ES–performance relationship lies in the supply chain literature. SCR is simply one competitive weapon enabling firms to respond effectively to changes in the market which, in turn, leads to superior operational performance. Other forms of supply chain strategies could be incorporated into the SIAP model to refine understanding of the effects of ES.

6.2 Managerial implications

The study findings suggest that ES activities provide useful information for developing a quick response supply chain (SCR) strategy to supply chain partners. As today's industries are becoming more competitive and dynamic, information from the external environment has become an important resource for firms to capitalize upon to enhance competitiveness. Our study suggests that managers should develop information processing strategies coupled with effective ES, especially for identifying, gathering and analyzing information about events and trends occurring outside the firm that are specifically related to establishing strategic collaboration, SCI and responsive supply chains. Since more than half of the operational performance benefit from ES is derived from SCI and SCR activities, top executives should learn to scan supply chain related environmental information and provide the information to supply chain managers; the goal being to work with such managers and supply chain partners to adapt to the changing environment.

Second, supply chain managers need to work with senior executives to obtain strategic signals from ES activities, serve as a conduit to facilitate joint interpretation of the strategic signals with business partners and transform them into strategic insights about changes in suppliers, customers, competitors and markets. Additionally, it is important to then reconfigure the supply chain to respond quickly to the changes. Without integrating these activities through the SIAP model (ES as scanning, SCI as interpretation and SCR as action), signals from ES and collaboration through SCI would not necessarily lead to better operational outcomes. Managers are advised to find ways to link ES

activities with processes for developing and implementing SCM practices, especially responsiveness and integration. Based on the OIPT argument that the levels of responsiveness and integration should be aligned with the levels of dynamic and changing competitive environment, we suggest three processes – ES activities in gathering sufficient and relevant information, SCI activities in processing and sharing the information with supply chain partners and SCR strategy – ought to be aligned. Bear in mind many firms have adopted process models such as the SCOR model. However, it is important to complement such models with the design of appropriate ES processes and link them to the supply chain strategy processes.

Third, while researchers have long articulated the benefits of building strategic collaboration among supply chain partners, our findings suggest supply chain managers should view SCI as a joint interpretation process and a potential preparation for big data initiatives. Managers should recognize the improved SCR associated with SCI instead of viewing SCI exclusively as an initiative to achieve cost efficiency. The mediation analysis strongly suggests that if firms focus only on developing a close and integrated relationship without developing a shared schema for interpreting the environmental information and translating insights from the shared information into quick actions, they may not be able to fully leverage the potential operational benefits. Our study reveals SCR is one of the key strategies that enable firms to achieve superior operational performance. While SCI did not directly affect operational performance it is, nevertheless, a key antecedent to the development of SCR. In fact, since all of the operational performance benefit of SCI is delivered through SCR, managers seeking to obtain operational benefits should invest in improving responsiveness in conjunction with SCI.

Fourth, as a mental model guiding managers to become more holistic and systems-oriented thinkers, this study provides an example of how the SIAP model can be a useful framework that helps managers better understand the ES–SCM practices (SCI/SCR)–performance relationships. With the emphasis on scanning “S” as the first step, this framework will be useful for managers considering implementing supply chain big data analytics to further consider other types of data to scan “S,” and different means to interpret “I,” including the use of artificial intelligence and machine learning, and to support a supply chain strategy be it responsiveness (SCR), lean, smart or intelligence. More importantly, using SIAP as a mental model drives a constant search for fits between strategy and the environment to better cope with today’s turbulent and uncertain environment.

7. Directions for future research

The study has a number of limitations that present opportunities for future research. First, our conceptualization of ES from a SIAP perspective focuses on gathering information about business environments from supply chain partners. The ES literature suggests that effective scanning of both the external environment and the internal circumstances of a firm is important to performance improvement (Garg *et al.*, 2003). Thus, future research should examine the aspects of both the firm’s external environment and its internal circumstances and their differential impacts on SCM and firm performance.

Second, another limitation is that this study conceptualized SCI as an aggregate construct. The SCI literature has examined SCI as a multidimensional construct inclusive of internal integration, customer integration and supplier integration (Flynn *et al.*, 2010). Thus, future research should investigate the different dimensions of SCI and their relative impact on responsiveness and firm performance.

Third, future research should examine the relationship between ES, SCM practices and firm performance in different economies to confirm the results obtained in this study. Studies that compare ES in a supply chain context in developed vs developing nations may also be of interest (Sawyer, 1993).

Fourth, this study considered SCR as the “action”. However, SCR might be investigated more granularly to determine which dimensions of responsiveness are most critical, e.g., volume or mix flexibility, price changes, supply base changes or investments.

Fifth, this study considered operational performance as an important performance outcome of SCI and SCR. However, previous research (e.g. Wu *et al.*, 2006; Yu *et al.*, 2018) suggests that integrated and responsive supply chains improve financial and marketing performance. Therefore, a possible direction for future research could be to examine how SCI and SCR bear on a wider range of performance measures.

Lastly, related to the sample, another limitation relates to the single respondent design. The perspectives of individuals within the firm may not be uniform or the respondent may not represent the dominant view within the firm. Multiple respondents at each firm could improve the study’s reliability and incorporating a broader range of industries could enhance generalizability.

8. Conclusions

Our study extends the SCM literature in several important ways. The first is through importing the SIAP model, which forms a bridge to the strategy literature and brings a new perspective to the supply chain literature. The use of the SIAP model enables a more precise application of the OIPT in the supply chain context. To the best of our knowledge, the use of the SIAP model herein is the first in an empirical study focused on comprehensively explaining the performance effects of ES through the development of two SCM practices – SCR and integration. The demonstration that the SIAP model serves as an integrative framework for refining understanding of the ES–SCI–SCR–performance leads to the implication that other scanning and SCM practices could be studied in a more comprehensive manner. The second implication is that this study positions OIPT in conjunction with the SIAP model as a new way to refine disparate knowledge on ES, SCI, SCR and performance. The SIAP model can also be extended to account for the environment and other explanatory variables. From a practical perspective our empirical findings, especially the indirect effect of ES through SCI and SCR, provide useful insights for supply chain managers and their top executives.

References

- Aguilar, F.J. (1967), *Scanning the Business Environment*, Macmillan Company, New York, NY.
- Ahituv, N., Zif, J. and Machlin, I. (1998), “Environmental scanning and information systems in relation to success in introducing new products”, *Information & Management*, Vol. 33 No. 4, pp. 201-211.
- Albright, K.S. (2004), “Environmental scanning: radar for success”, *Information Management Journal*, Vol. 38 No. 3, pp. 38-45.
- Ambulkar, S., Blackhurst, J. and Grawe, S. (2015), “Firm’s resilience to supply chain disruptions: scale development and empirical examination”, *Journal of Operations Management*, Vols 33-34 No. 1, pp. 111-122.
- Armstrong, J.S. and Overton, T.S. (1977), “Estimating nonresponse bias in mail surveys”, *Journal of Marketing Research*, Vol. 14 No. 3, pp. 396-402.
- Badri, M.A., Davis, D. and Davis, D. (2000), “Operations strategy, environmental uncertainty and performance: a path analytic model of industries in developing countries”, *Omega*, Vol. 28 No. 2, pp. 155-173.
- Baron, R. and Kenny, D. (1986), “The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations”, *Journal of Personality and Social Psychology*, Vol. 51 No. 6, pp. 1173-1182.
- Barringer, B.R. and Bluedorn, A.C. (1999), “The relationship between corporate entrepreneurship and strategic management”, *Strategic Management Journal*, Vol. 20 No. 5, pp. 421-444.

- Beal, R.M. (2000), "Competing effectively: environmental scanning, competitive strategy and organizational performance in small manufacturing firms", *Journal of Small Business Management*, Vol. 38 No. 1, pp. 26-34.
- Bergeron, P. (2000), "Regional business intelligence: the view from Canada", *Journal of Information Science*, Vol. 26 No. 3, pp. 153-160.
- Bode, C., Wagner, S.M., Petersen, K.J. and Ellram, L.M. (2011), "Understanding responses to supply chain disruptions: insights from information processing and resource dependence perspectives", *Academy of Management Journal*, Vol. 54 No. 4, pp. 833-856.
- Bourgeois, L.J. (1980), "Strategy and environment: a conceptual integration", *Academy of Management Review*, Vol. 5 No. 1, pp. 25-39.
- Bowersox, D.J., Closs, D.J. and Stank, T.P. (2003), "How to master cross-enterprise collaboration", *Supply Chain Management Review*, Vol. 7 No. 4, pp. 18-27.
- Busse, C., Meinschmidt, J. and Foerstl, K. (2017), "Managing information processing needs in global supply chains: a prerequisite to sustainable supply chain management", *Journal of Supply Chain Management*, Vol. 53 No. 1, pp. 87-113.
- Cao, M. and Zhang, Q. (2011), "Supply chain collaboration: impact on collaborative advantage and firm performance", *Journal of Operations Management*, Vol. 29 No. 3, pp. 163-180.
- Castanias, R. and Helfat, C. (2001), "The managerial rents model: theory and empirical analysis", *Journal of Management*, Vol. 27 No. 6, pp. 661-678.
- Chavez, R., Yu, W., Gimenez, C., Fynes, B. and Wiengarten, F. (2015), "Customer integration and operational performance: the mediating role of information quality", *Decision Support Systems*, Vol. 80, December, pp. 83-95.
- Chen, H., Daugherty, P.J. and Landry, L.D. (2009), "Supply chain process integration: a theoretical framework", *Journal of Business Logistics*, Vol. 30 No. 2, pp. 27-46.
- Choudhury, V. and Sampler, J.L. (1997), "Information specificity and environmental scanning: an economic perspective", *MIS Quarterly*, Vol. 21 No. 1, pp. 25-53.
- Chow, G., Heaver, T.D. and Henriksson, L.E. (1995), "Strategy, structure and performance: a framework for logistics research", *Logistics and Transportation Review*, Vol. 31 No. 4, pp. 285-308.
- Christopher, M. and Peck, H. (2004), "Building the resilient supply chain", *International Journal of Logistics Management*, Vol. 15 No. 2, pp. 1-14.
- Closs, D., Speier, C., Whipple, J. and Voss, M.D. (2008), "A framework for protecting your supply chain", *Supply Chain Management Review*, Vol. 12 No. 2, pp. 38-45.
- Cousins, P.D., Lawson, B., Petersen, K.J. and Handfield, R.B. (2011), "Breakthrough scanning, supplier knowledge exchange, and new product development performance", *Journal of Product Innovation Management*, Vol. 28 No. 6, pp. 930-942.
- Cuhl, K. (2003), "From forecasting to foresight processes – new participative foresight activities in Germany", *Journal of Forecasting*, Vol. 22 Nos 2-3, pp. 93-111.
- Daft, R.L. and Lengel, R.H. (1986), "Organizational information requirements, media richness and structural design", *Management Science*, Vol. 32 No. 5, pp. 554-571.
- Daft, R.L. and Macintosh, N.B. (1981), "A tentative exploration into the amount and equivocality of information processing in organizational work units", *Administrative Science Quarterly*, Vol. 26 No. 2, pp. 207-224.
- Daft, R.L. and Weick, K.E. (1984), "Toward a model of organizations as interpretation systems", *Academy of Management Review*, Vol. 9 No. 2, pp. 284-295.
- Daft, R.L., Sormunen, J. and Parks, D. (1988), "Chief executive scanning, environmental characteristics, and company performance: an empirical study", *Strategic Management Journal*, Vol. 9 No. 2, pp. 123-139.
- Danese, P., Romano, P. and Formentini, M. (2013), "The impact of supply chain integration on responsiveness: the moderating effect of using an international supplier network", *Transportation Research Part E: Logistics and Transportation Review*, Vol. 49 No. 1, pp. 125-140.

- Droge, C., Vickery, S.K. and Jacobs, M. (2012), "Does supply chain integration mediate the relationships between product/process strategy and service performance? An empirical study", *International Journal of Production Economics*, Vol. 137 No. 2, pp. 250-262.
- Dutton, J.E. and Duncan, R.B. (1987), "The creation of momentum for change through the process of strategic issue diagnosis", *Strategic Management Journal*, Vol. 8 No. 3, pp. 279-295.
- Ebrahimi, B.P. (2000), "Perceived strategic uncertainty and environmental scanning behavior of Hong Kong Chinese executives", *Journal of Business Research*, Vol. 49 No. 1, pp. 67-77.
- Elenkov, D.S. (1997), "Strategic uncertainty and environmental scanning: the case for institutional influences on scanning behavior", *Strategic Management Journal*, Vol. 18 No. 4, pp. 287-302.
- Fabbe-Costes, N., Roussat, C. and Colin, J. (2011), "Future sustainable supply chains: what should companies scan in their environment?", *International Journal of Physical Distribution and Logistics Management*, Vol. 41 No. 3, pp. 228-252.
- Fabbe-Costes, N., Roussat, C., Taylor, M. and Taylor, A. (2014), "Sustainable supply chains: a framework for environmental scanning practices", *International Journal of Operations & Production Management*, Vol. 34 No. 5, pp. 664-694.
- Flynn, B.B. and Flynn, E.J. (1999), "Information-processing alternatives for coping with manufacturing environmental complexity", *Decisions Science*, Vol. 30 No. 4, pp. 1021-1052.
- Flynn, B.B., Huo, B. and Zhao, X. (2010), "The impact of supply chain integration on performance: a contingency and configuration approach", *Journal of Operations Management*, Vol. 28 No. 1, pp. 58-71.
- Fornell, C. and Larcker, D.F. (1981), "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, Vol. 18 No. 1, pp. 29-50.
- Galbraith, J.R. (1973), *Designing Complex Organizations*, Addison-Wesley, Reading, MA.
- Garg, V., Walters, B. and Priem, R. (2003), "Chief executive scanning emphases, environmental dynamism and manufacturing firm performance", *Strategic Management Journal*, Vol. 24 No. 8, pp. 725-744.
- Gattiker, T.F. and Goodhue, D.L. (2004), "Understanding the local-level costs and benefits of ERP through organizational information processing theory", *Information & Management*, Vol. 41 No. 4, pp. 431-443.
- Gerbing, D.W. and Anderson, J.C. (1988), "An updated paradigm for scale development incorporating unidimensionality and its assessment", *Journal of Marketing Research*, Vol. 25 No. 2, pp. 186-192.
- Gioia, D.A. and Chittipeddi, K. (1991), "Sensemaking and sensegiving in strategic change initiation", *Strategic Management Journal*, Vol. 12 No. 6, pp. 433-448.
- Goodhue, D.L., Wybo, M.D. and Kirsch, L.J. (1992), "The impact of data integration on the costs and benefits of information systems", *MIS Quarterly*, Vol. 16 No. 3, pp. 293-311.
- Gunasekaran, A., Lai, K.H. and Cheng, T.C.E. (2008), "Responsive supply chain: a competitive strategy in a networked economy", *Omega*, Vol. 36 No. 4, pp. 549-564.
- Hair, J.F. Jr, Black, W.C., Babin, B.J., Anderson, R.E. and Tatham, R.L. (2010), *Multivariate Data Analysis*, 7th ed., Pearson Education, Upper Saddle River, NJ.
- Hambrick, D.C. (1981), "Specialization of environmental scanning activities among upper level executives", *Journal of Management Studies*, Vol. 18 No. 3, pp. 299-320.
- Hambrick, D.C. (1982), "Environmental scanning and organizational strategy", *Strategic Management Journal*, Vol. 3 No. 2, pp. 159-174.
- Holsapple, C. and Jones, K. (2005), "Exploring secondary activities of the knowledge chain", *Knowledge and Process Management*, Vol. 12 No. 1, pp. 3-31.
- Hough, J.R. and White, M.A. (2004), "Scanning actions and environmental dynamism: gathering information for strategic decision making", *Management Decision*, Vol. 42 No. 6, pp. 781-793.

- Hu, L. and Bentler, P.M. (1999), "Cut-off criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives", *Structural Equation Modelling: A Multidisciplinary Journal*, Vol. 6 No. 1, pp. 1-55.
- Hult, G.T.M., Ketchen, D.J. and Slater, S.F. (2004), "Information processing, knowledge development, and strategic supply chain performance", *Academy of Management Journal*, Vol. 47 No. 2, pp. 241-253.
- Huo, B. (2012), "The impact of supply chain integration on company performance: an organizational capability perspective", *Supply Chain Management: An International Journal*, Vol. 17 No. 6, pp. 596-610.
- Huo, B., Zhao, X. and Zhou, H. (2014), "The effects of competitive environment on supply chain information sharing and performance: an empirical study in China", *Production and Operations Management*, Vol. 23 No. 4, pp. 552-569.
- Jacobs, M. (2007), "Product complexity: a definition and impacts on organizations", *Decision Line*, Vol. 38 No. 5, pp. 7-8.
- Jacobs, M., Vickery, S. and Droge, C. (2007), "The effects of product modularity on competitive performance: do integration strategies mediate the relationship?", *International Journal of Operations and Production Management*, Vol. 27 No. 10, pp. 1046-1068.
- Jacobs, M., Yu, W. and Chavez, R. (2016), "The effect of internal communication and employee satisfaction on supply chain integration", *International Journal of Production Economics*, Vol. 171 No. 1, pp. 60-70.
- Jacobs, M., Droge, C., Vickery, S. and Calantone, R. (2011), "The effect of product and process modularity on agility and firm growth performance", *Journal of Product Innovation Management*, Vol. 28 No. 1, pp. 124-138.
- Kahneman, D. and Tversky, A. (1984), "Choice, values, and frames", *American Psychologist*, Vol. 39 No. 4, pp. 341-350.
- Kim, D. and Lee, R.P. (2010), "Systems collaboration and strategic collaboration: their impacts on supply chain responsiveness and market performance", *Decision Sciences*, Vol. 41 No. 4, pp. 955-981.
- Kim, D., Cavusgil, S.T. and Calantone, R.J. (2006), "Information system innovations and supply chain management: channel relationships and firm performance", *Journal of Academy of Marketing Science*, Vol. 34 No. 1, pp. 40-54.
- Kim, S.W. (2009), "An investigation on the direct and indirect effect of supply chain integration on firm performance", *International Journal of Production Economics*, Vol. 119 No. 2, pp. 328-346.
- Koufteros, X., Vickery, S.K. and Dröge, C. (2012), "The effects of strategic supplier selection on buyer competitive performance in matched domains: does supplier integration mediate the relationships?", *Journal of Supply Chain Management*, Vol. 48 No. 2, pp. 93-115.
- Koufteros, X., Vonderembse, M. and Jayaram, J. (2005), "Internal and external integration for product development: the contingency effects of uncertainty, equivocality, and platform strategy", *Decision Sciences Journal*, Vol. 36 No. 1, pp. 97-133.
- Lee, H.L. (2002), "Aligning supply chain strategies with product uncertainties", *California Management Review*, Vol. 44 No. 3, pp. 105-119.
- Lee, H.L. (2004), "The triple-a supply chain", *Harvard Business Review*, Vol. 82 No. 10, pp. 102-112.
- McGee, J.E. and Sawyerr, O.O. (2003), "Uncertainty and information search activities: a study of owner-managers of small high-technology manufacturing firms", *Journal of Small Business Management*, Vol. 41 No. 4, pp. 385-401.
- Mackelprang, A.W., Robinson, J.L., Bernardes, E. and Webb, G.S. (2014), "The relationship between supply chain integration and performance: a meta-analytic evaluation and implications for supply chain management research", *Journal of Business Logistics*, Vol. 35 No. 1, pp. 71-96.
- Malhotra, M.K. and Mackelprang, A.W. (2012), "Are internal manufacturing and external supply chain flexibilities complementary capabilities?", *Journal of Operations Management*, Vol. 30 No. 3, pp. 180-200.

- Miller, D. and Friesen, P.H. (1982), "Innovation in conservative and entrepreneurial firms: two models of strategic momentum", *Strategic Management Journal*, Vol. 3 No. 1, pp. 1-25.
- Milliken, F.J. (1990), "Perceiving and interpreting environmental change: an examination of college administrators' interpretation of changing demographics", *Academy of Management Journal*, Vol. 33 No. 1, pp. 42-63.
- Mintzberg, H. (1973), "Strategy making in three modes", *California Management Review*, Vol. 16 No. 2, pp. 44-53.
- Nair, A., Yan, T., RO, Y., Oke, A., Chiles, T. and Lee, S. (2016), "How environmental innovations emerge and proliferate in supply networks: a complex adaptive systems perspective", *Journal of Supply Chain Management*, Vol. 52 No. 2, pp. 66-86.
- O'Leary-Kelly, S.W.O. and Vokurka, R.J. (1998), "The empirical assessment of construct validity", *Journal of Operations Management*, Vol. 16 No. 4, pp. 387-405.
- Oliver, N., Holweg, M. and Carver, M. (2008), "A systems perspective on the death of a car company", *International Journal of Operations and Production Management*, Vol. 28 No. 6, pp. 562-583.
- Paiva, E.L., Roth, A.V. and Fensterseifer, J.E. (2008), "Organizational knowledge and the manufacturing strategy process: a resource-based view analysis", *Journal of Operations Management*, Vol. 26 No. 1, pp. 115-132.
- Podsakoff, P.M., MacKenzie, S., Lee, J. and Podsakoff, N. (2003), "Common method biases in behavioral research: a critical review of the literature and recommended remedies", *Journal of Applied Psychology*, Vol. 88 No. 5, pp. 879-903.
- Preacher, K.J. (2015), "Advances in mediation analysis: a survey and synthesis of new developments", *Annual Review of Psychology*, Vol. 66 No. 1, pp. 825-852.
- Qrunfleh, S. and Tarafdar, M. (2013), "Lean and agile supply chain strategies and supply chain responsiveness: the role of strategic supplier partnership and postponement", *Supply Chain Management: An International Journal*, Vol. 18 No. 6, pp. 571-582.
- Ralston, P.M., Blackhurst, J., Cantor, D.E. and Crum, M.R. (2015), "A structure-conduct-performance perspective of how strategic supply chain integration affects firm performance", *Journal of Supply Chain Management*, Vol. 51 No. 2, pp. 47-64.
- Sanders, N.R. (2007), "An empirical study of the impact of e-business technologies on organizational collaboration and performance", *Journal of Operations Management*, Vol. 25 No. 6, pp. 1332-1347.
- Sanders, N.R., Aurty, C. and Gligor, D. (2011), "The impact of buyer firm information connectivity enablers on supplier firm performance: a relational view", *The International Journal of Logistics Management*, Vol. 22 No. 2, pp. 179-201.
- Sawyer, O.O. (1993), "Environmental uncertainty and environmental scanning activities of Nigerian manufacturing executives: a comparative analysis", *Strategic Management Journal*, Vol. 14 No. 4, pp. 287-299.
- Scheonherr, T. and Swink, M. (2012), "Revisiting the arcs of integration: cross-validations and extensions", *Journal of Operations Management*, Vol. 30 Nos 1/2, pp. 99-115.
- Sheu, C., Yen, H.R. and Chae, D. (2006), "Determinants of supplier-retailer collaboration: evidence from an international study", *International Journal of Operations and Production Management*, Vol. 26 No. 1, pp. 24-49.
- Skipworth, H., Godsell, J., Wong, C.Y., Saghiri, S. and Julien, D. (2015), "Supply chain alignment for improved business performance: an empirical study", *Supply Chain Management: An International Journal*, Vol. 20 No. 5, pp. 511-533.
- Smith, K.G., Grimm, C.M., Gannon, M. and Chen, M.J. (1991), "Organizational information processing: competitive response and performance in the US domestic airline industry", *Academy of Management Journal*, Vol. 34 No. 1, pp. 60-85.
- Srinivasan, M., Mukherjee, D. and Gaur, A.S. (2011), "Buyer-supplier partnership quality and supply chain performance: moderating role of risks and environmental uncertainty", *European Management Journal*, Vol. 29 No. 4, pp. 260-271.

- Srinivasan, R. and Swink, M. (2015), "Leveraging supply chain integration through planning comprehensiveness: an organizational information processing theory perspective", *Decision Sciences*, Vol. 46 No. 5, pp. 823-861.
- Stalk, G. and Hout, T. (1990), *Competing Against Time*, Free Press, New York, NY.
- Stoffels, J.D. (1994), *Strategic Issues Management: A Comprehensive Guide to Environmental Scanning*, Pergamon, Oxford, OH.
- Swink, M. and Schoenherr, T. (2015), "The effects of cross-functional integration on profitability, process efficiency, and asset productivity", *Journal of Business Logistics*, Vol. 36 No. 1, pp. 69-87.
- Swink, M.L., Narasimhan, R. and Wang, C. (2007), "Managing beyond the factory walls: effects of four types of strategic integration on manufacturing plant performance", *Journal of Operations Management*, Vol. 25 No. 1, pp. 148-164.
- Thomas, J.B., Clark, S.M. and Gioia, D.A. (1993), "Strategic sensemaking and organizational performance: linkages among scanning, interpretation, action and outcomes", *Academy of Management Journal*, Vol. 36 No. 2, pp. 239-270.
- Van Hoek, R.I., Harrison, A. and Christopher, M. (2001), "Measuring agile capabilities in the supply chain", *International Journal of Operations & Production Management*, Vol. 21 Nos 1-2, pp. 126-147.
- Vickery, S.K., Jayaram, J., Droge, C. and Calantone, R. (2003), "The effects of an integrative supply chain strategy on customer service and financial performance: an analysis of direct versus indirect relationships", *Journal of Operations Management*, Vol. 21 No. 5, pp. 523-539.
- Wang, E.T.G. and Wei, H. (2007), "Interorganizational governance value creation: coordinating for information visibility and flexibility in supply chains", *Decision Sciences*, Vol. 38 No. 4, pp. 647-674.
- Weick, K.E. (1979), *The Social Psychology of Organizing*, Addison-Wesley, Reading, MA.
- Williams, B.D., Roh, J., Tokar, T. and Swink, M. (2013), "Leveraging supply chain visibility for responsiveness: the moderating role of internal integration", *Journal of Operations Management*, Vol. 31 Nos 7-8, pp. 543-554.
- Wong, C.Y. and Hvolby, H.-H. (2007), "Coordinated responsiveness for volatile toy supply chains", *Production Planning and Control*, Vol. 18 No. 5, pp. 407-419.
- Wong, C.Y., Boon-itt, S. and Wong, C.W.Y. (2011), "The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance", *Journal of Operations Management*, Vol. 29 No. 6, pp. 604-615.
- Wu, F., Yeniyurt, S., Kim, D. and Cavusgil, S.T. (2006), "The impact of information technology on supply chain capabilities and firm performance: a resource-based view", *Industrial Marketing Management*, Vol. 35 No. 4, pp. 493-504.
- Yasai-Ardekani, M. and Nystrom, P.C. (1996), "Designs for environmental scanning systems: tests of a contingency theory", *Management Science*, Vol. 42 No. 2, pp. 187-204.
- Yu, W. (2015), "The effect of IT-enabled supply chain integration on performance", *Production Planning & Control*, Vol. 26 No. 12, pp. 945-957.
- Yu, W., Chavez, R., Feng, M. and Wiengarten, F. (2014), "Integrated green supply chain management and operational performance", *Supply Chain Management: An International Journal*, Vol. 19 Nos 5/6, pp. 683-696.
- Yu, W., Chavez, R., Jacobs, M.A. and Feng, M. (2018), "Data-driven supply chain capabilities and performance: a resource-based view", *Transportation Research Part E: Logistics and Transportation Review*, Vol. 114, June, pp. 371-385.
- Yu, W., Jacobs, M.A., Chavez, R. and Feng, M. (2017), "The impacts of IT capability and marketing capability on supply chain integration: a resource-based perspective", *International Journal of Production Research*, Vol. 55 No. 14, pp. 4196-4211.

- Yu, W., Jacobs, M.A., Salisbury, W.D. and Enns, H. (2013), "The effects of supply chain integration on customer satisfaction and financial performance: an organizational learning perspective", *International Journal of Production Economics*, Vol. 146 No. 1, pp. 346-358.
- Zhao, X., Flynn, B.B. and Roth, A.V. (2006), "Decision sciences research in China: a critical review and research agenda—foundations and overview", *Decision Sciences*, Vol. 37 No. 4, pp. 451-496.
- Zhao, X., Lynch, J.G. and Chen, Q. (2010), "Reconsidering Baron and Kenny: myths and truths about mediation analysis", *Journal of Consumer Research*, Vol. 37 No. 2, pp. 197-206.
- Zhao, X., Huo, B., Selend, W. and Yeung, J.H.Y. (2011), "The impact of internal integration and relationship commitment on external integration", *Journal of Operations Management*, Vol. 29 Nos 1-2, pp. 17-32.
- Zsidisin, G., Hartley, J., Bernardes, E. and Saunders, L. (2015), "Examining supply market scanning and internal communication climate as facilitators of supply chain integration", *Supply Chain Management: An International Journal*, Vol. 20 No. 5, pp. 549-560.

Further reading

- Christopher, M. and Ryals, L. (1999), "Supply chain strategy: its impact on shareholder value", *International Journal of Logistics Management*, Vol. 10 No. 1, pp. 1-10.

Appendix. Questionnaire

- (1) Environmental scanning: please indicate the extent to which the following scanning devices are used by your firm to gather information about its environment (1 = Not ever used; 7 = Used extremely frequently).
 - Routine gathering of opinions from clients.
 - Explicit tracking of the policies and tactics of competitors.
 - Forecasting sales and customer preferences.
 - Special marketing research studies.
 - Gathering of information from suppliers and other channel members.
- (2) Supply chain integration: please indicate the degree to which you agree to the following statements relating to your company's supply chain capability (1 = strongly disagree; 7 = strongly agree).
 - Our company develops strategic plans in collaboration with our partners.
 - Our company collaborates actively in forecasting and planning with our partners.
 - Our company projects and plans future demand collaboratively with our partners.
 - Collaboration in demand forecasting and planning with our partners is something we always do in our company.
 - Our company always forecasts and plans activities collaboratively with our partners.
- (3) Supply chain responsiveness: please indicate the degree to which you agree to the following statements relating to your company's supply chain capability (1 = strongly disagree; 7 = strongly agree).
 - Compared to our competitors, our supply chain responds more quickly and effectively to changing customer and supplier needs.
 - Compared to our competitors, our supply chain responds more quickly and effectively to changing competitor strategies.

- Compared to our competitors, our supply chain develops and markets new products more quickly and effectively.
- In most markets, our supply chain is competing effectively.
- The relationship with our partner has increased our supply chain responsiveness to market changes through collaboration.

- (4) Operational performance: please evaluate the scale below how your firm compares to your major industrial competitors over the last three years (1 = much worse than your major competitors; 7 = much better than your major competitors).
- Rapidly change production volume.
 - Deliver products quickly or short lead-time.
 - Provide on-time delivery to our customers.
 - Provide reliable delivery to our customers.
 - Produce consistent quality products with low defects.
 - Produce products with low inventory costs.

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